SP-F3.2 Evaluation of Project Effects on Non-Salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam

October 25, 2002

1.0 Introduction/Background

Operations of the Oroville Facilities can result in varying flow rates in the Feather River. Flow fluctuations and changes in river stage may affect colonization of rooted aquatic vegetation in the riparian zone, resulting in changes in terrestrial vegetation establishment within the fluctuation zone (DWR 2001). Inundated vegetation provides spawning and nursery habitat for warmwater fisheries, offers protection from predation and results in increased food availability for warmwater and coldwater fisheries (DWR 2001; DWR and USBR 2000). Changes in such cover may result in changes in fish populations (DWR 2001). Additionally, variations in flow may affect water temperature, spawning habitat availability, egg incubation success, and juvenile survival, all of which are factors in determining n fisheries success in the Feather River (DWR 2001).

The lower Feather River supports a variety of fish species. The Feather River warmwater sport fishery is composed of fish of the *Centrarchidae* (sunfish) family including four species of black bass (*Micropterus punctulatus, M. salmoides, M. dolomieui, and M. coosae),* three species of sunfish (*Lepomis macrochirus, L. cyanellus, and L. microlophus),* and two species of crappie (*Pomoxis nigromaculatus* and *P. annularis)* (DWR 2001). Additionally, striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) are also common targets for anglers. The Feather River also provides habitat for many other fish species, including native fish (e.g., Sacramento pikeminnow (*Ptychocheilus grandis),* hardhead (*Mylopharodon conocephalus),* Sacramento sucker (*Catostomus occidentalis),* splittail (*Pogonichthys macrolepidotus),* river lamprey (*Lamptera ayresi*), Pacific lamprey (*Lamptera tridentat*a), tule perch (*Hysterocarpus traski*), green sturgeon (*Acipenser medirostris*), and white sturgeon (*Acipenser transmontanus*)), and introduced fish (e.g., carp (*Cyprinus carpio),* wakasagi (*Hypomesis nipponensis),* and threadfin shad (*Dorosoma petenense*)).

This study plan is designed to address non-salmonid fish that reside in the study area, including non-salmonid fish that migrate downstream of the Thermalito Diversion Dam. Although it is recognized that all fish in the study area fulfill an ecological role and that this review may include many fish species in the study area, the tasks in this plan will focus on fish species named below. For the purpose of this study, non-salmonid fish in the reach of the Feather River downstream of the Thermalito Diversion Dam have been assigned to two groups: Group A and Group B. Group A species include those which are federally and state-listed threatened or endangered species, species which are candidates for listing, and species which are California species of special concern, including green sturgeon, splittail, and river lamprey. Splittail are federally listed as threatened, while green sturgeon (a candidate for listing) and river lamprey are California species of special concern. Group B species include native fish and sportfish and include members of the centrarchid family (bass and sunfish), striped bass, American shad, hardhead, hitch, Pacific lamprey, pikeminnow, sucker, tule perch, and white sturgeon.

The use of the term "fish" in this study is used with the knowledge that although any non-salmonid fish may be included, the general focus of this plan is on fish named in Groups A and B. This study plan does not evaluate project effects on salmonids. Potential project effects on salmonids will be addressed in SP-

F10-Evaluation of Project Effects on Salmonids and Their Habitat in the Feather River Below the Fish Barrier Dam.

2.0 Study Objective

The study plan objective is to document non-salmonid fish species distribution and to evaluate potential project effects on non-salmonid fish habitat within the study area. Additionally, the study plan will establish tools to evaluate future potential operational scenarios and other protection, mitigation and enhancement measures (PMEs).

Individual task objectives include:

- Task 1: Documenting the distribution of non-salmonid fish species observed in the Feather River downstream of the Thermalito Diversion Dam to the Sacramento River confluence;
- Task 2: Describing the life history and habitat requirements of non-salmonid fish species in the Feather River downstream of the Thermalito Diversion Dam to the Sacramento River confluence;
- Task 3: Completing identified field data collection efforts and specific analyses for green sturgeon and splittail;
- Task 4: Identifying fish habitat in the Feather River from the Thermalito Diversion Dam to the Sacramento River confluence as it pertains to species-specific habitat requirements; and
- Task 5: Assessing potential project effects on non-salmonid fish species.

3.0 Relationship to Relicensing/Need for the Study

This study is needed because project operations influence flow rates, river stage, habitat availability, water temperature and other factors contributing to the success of fish populations within the study area. Changes in river stage can change the availability of inundated riparian vegetation used by fish for spawning and rearing, therefore affecting spawning and rearing success and subsequent year-class strength. In addition, changes in flow and river stage during the primary period for fish nest-building and spawning may affect initial year-class strength. Project operations may affect the distribution of Feather River fish, change the availability and quality of fish habitat, and change the magnitude, frequency and timing of flow and water temperatures in the Feather River, thus potentially influencing migration and emigration timing as well as egg and juvenile development. Therefore, this study is necessary to evaluate potential project impacts on fish and their habitat in the Feather River downstream of the Fish Barrier Dam.

Section 4.51(f)(3) of 18 CFR requires reporting of certain types of information in the FERC Application for License for major hydropower projects, including a discussion of the fish, wildlife and botanical resources in the vicinity of the project. The discussion needs to identify the potential impacts of the project on these resources, including a description of any anticipated continuing impact for on-going and future operation of the project. In addition to fulfilling these requirements, information developed in this study plan also may be used in determining appropriate protection, mitigation and enhancement (PM&E) measures.

4.0 Study Area

The proposed study area encompasses the Feather River downstream of the Thermalito Diversion Dam to its confluence with the Sacramento River. The Thermalito Diversion Dam is named as the upstream extent of this study plan because it is likely that evaluation of suggested PM&Es will require a description of the fish habitat in the Fish Barrier Pool and the potential project effects on that habitat under various operational scenarios. The Fish Barrier Pool is a reservoir, not a riverine environment. However, it is included in this plan because of the potential for PM&Es to suggest allowing in-river fish passage into the Fish Barrier Pool. The Feather River confluence with the Sacramento River is the downstream boundary of this study plan. Study plans approved by the Environmental Work Group define the limits of the study area. If initial study results indicate that the study area should be expanded or contracted, the Environmental Work Group will discuss the basis for change and revise the study area as appropriate.

5.0 General Approach

This study is designed primarily as a desktop study to assemble and summarize general information regarding fish species and their habitat requirements, and to evaluate potential effects on fish habitat, and resultant impacts on fish populations, within the study area. However, a field study component is included and is intended to provide supplementary data regarding fish distribution and habitat preferences for cases in which a lack of sufficient available information to fulfill the study objectives based on a desktop study has been identified. The study plan is structured as a five-task study. If initial study results indicate that the methods and tasks should be modified, the Environmental Work Group will discuss the basis for change and revise the study plans as appropriate.

In Task 1, the relative distribution of fish observed in the Feather River, including those that are not specifically listed in groups A and B (see 1.0 Introduction), will be documented. In Task 2, a literature review will be conducted to describe the biological requirements and habitat characteristics of fish in Groups A and B. For Group A species, directed, focused field efforts and/or analyses have been identified which take into account the current knowledge of the species abundance and distribution in the Feather River. Because splittail is federally listed and green sturgeon is a candidate for listing, these two species have been addressed through specific analyses and field data collection efforts in Tasks 3A and 3B. Task 4 will describe the existing habitat characteristics of the Feather River. Under Task 5, the habitat characteristics and biological requirements from Task 2 will be compared to the existing habitat characteristics of the Feather River that are described in Task 4 to determine the potential effects of ongoing operations (Task 5A) and potential effects of alternative operational scenarios (Task 5B). Additionally, if any exceedances of water quality standards for freshwater aquatic life are reported in SP-W1, the impacts of the exceedances on non-salmonid fish will be evaluated under Task 5A.

The study plan is organized into the following five tasks:

1. Document the distribution of non-salmonid fish species observed in the Feather River downstream of the Thermalito Diversion Dam to the Sacramento River confluence;
2. Sacramento River confluence;
3. Complete identified field data collection efforts and specific analyses for green sturgeon and splittail;

4. Identify fish habitat in the Feather River from the Thermalito Diversion Dam to the Sacramento River confluence as it pertains to species-specific habitat requirements; and
5. Assess potential project effects on non-salmonid fish species.

In order to achieve the final objective of assessing potential project effects on fish and their habitat, information from many sources must be integrated and summarized. Although some available information may focus on salmonids, habitat and distribution information in these reports may be applicable to the non-salmonid fish that are the focus of this study. Literature review may include, but is not limited to, the following existing sources:

- DWR-ESO records of operation (December - June) of rotary screw traps, fyke traps, and seining - Abundance and emigration timing of juvenile salmon and steelhead since 1996.
- DWR-ESO study begun in Spring of 1999 -Distribution and habitat use of juvenile salmon and steelhead which utilizes snorkeling observations (March - August) on the Feather River between the Fish Barrier Dam and Gridley Bridge. Depth, current velocity, substrate, in-stream cover, over-head cover are recorded.
- DWR-ESO mapping studies in 1999, and 1992 IFIM studies - riffles, pools, glides and backwater habitats have been delineated on aerial photographs from the Fish Barrier Dam to the Gridley Bridge.
- DWR Northern District published Feather River gravel condition reports in 1982 and 1996.
- Historic stream flows in the low flow channel and below Thermalito Afterbay outlet.
- DWR-ESO Hourly temperature recordings at 20 sites between the Thermalito Diversion Dam and Live Oak -began in 1997 but records are incomplete until 1999.
- USGS temperature records at gage downstream from Oroville Dam, 1958 to 1992; continuous temperatures since 1995 by DWR.
- OFD mean daily water temperatures recorded at the Feather River Hatchery since initiation of hatchery operations, and Robinson Riffle since July 31, 2000.
- USGS records of maximum and minimum daily water temperatures at the Thermalito Afterbay Outlet from October 1968 through September of 1992. Since 1992, only mean daily water temperature data is available from OFD.
- River temperature model developed by UC Davis under contract with DWR-ESO in 2000.
- DWR-ESO instream flow study from 1992. Thirty-two transects selected between the Fish Barrier Dam and Honcut Creek. Salmon, steelhead and American shad were the target species.
- Macroinvertebrate food base available for rearing salmon and steelhead. Study began in Fall 2000 and will continue for two years. Funded by DWR-ESO through contract with Chico State University.
- DWR-ESO study begun in Fall 2000 regarding stranding and redd dewatering. Study will identify potential stranding areas between the Fish Barrier Dam and Honcut Creek.
- DFG: An Evaluation of Fish Populations and Fisheries in the Post-Oroville Project Feather River, 1977.
- DFG: Strategic Plan for Trout Management.
- DFG: Feather River Hatchery Production Goals and Constraints (Operational Plans).
- Current DFG/NMFS assessment of hatchery impacts.
- DWR/DFG water temperature criteria for the Feather River Hatchery.
- National Marine Fisheries Service temperature criteria for the Feather River at Robinson Riffle (low flow channel) in the 2001 biological opinion.

- Other historic literature related to fish habitat within the FERC project waters and the Feather River downstream to Yuba River.
- Information from reports, fish surveys and creel census performed by DFG or other agencies (e.g., Painter et al. 1977).
- 1982 DWR Feather River Spawning Gravel Baseline Study.
- 1967 USGS report, "Sediment Transport in the Feather River, Lake Oroville to Yuba City, California.
- NMFS Habitat Conservation Plan with DFG on striped bass stocking program.
- U.C. Davis study (on-going): Biological Assessment of Green Sturgeon in the Sacramento-San Joaquin Watershed.
- Concurrent studies occurring as part of the Oroville Facilities FERC relicensing process.

Detailed Methodology and Analysis Procedures

Task 1—Document the Distribution of Non-salmonid Fish Species Observed in the Feather River Downstream of the Thermalito Diversion Dam to the Sacramento River Confluence

This task consists of a general review of existing information sources previously listed as well as additional reports or studies by federal and state agencies, scientific papers, creel census reports, and other miscellaneous sources such as regional newspapers and possible interviews with private parties in the Central Valley, particularly local sportfishing guides and recreational fishing clubs, to document species composition, distribution, and relative abundance of fish in the study area. Distribution data will be compiled for fish observed in the Feather River, including those not specifically listed in Groups A and B. This data will come from many sources including snorkel surveys (broad-scale), existing seining data, rotary screw trap data, fyke trap data, and creel surveys. In addition to data summarized in reports and scientific papers, data that has not yet been summarized is expected to provide additional useful information. If existing, relevant data that has not been analyzed and incorporated into existing reports it may be examined under Task 1 as a supplemental effort to improve our knowledge of fish distribution in the Feather River. For example, although data describing the relative distribution of pikeminnow is obtained during DWR snorkel surveys, it is not necessarily included in summary reports. Such raw data will be examined, analyzed, and incorporated as appropriate for describing the relative distribution of pikeminnow. Additionally, data collected as part of creel surveys, but not reported in the original report, may be re-examined for distribution data for fish that were observed during the effort, but that were not the target of analysis, and therefore not included in the report. An example of this type of data mining analysis is to utilize existing creel data for angler catch rates for striped bass to determine striped bass distribution. Contingent on the information available, this review will include the following topics:

- Temporal and geographic distribution of fish by species;
- Characterization of the relative abundance of fish including, as available, seasonal and geographic variations in relative abundance; and
- Characterization of interannual variability in geographic distribution of fish.

A draft report describing the findings of Task 1 following the first year of data collection (snorkel surveys, existing seining data, rotary screw trap data, fyke trap data, and creel surveys) will be completed by December of 2002. It is anticipated that existing information will not be sufficient to document the distribution of green

sturgeon in the study area, and field studies are proposed in Task 3 to fill identified data gaps. The final report will incorporate results of 2003 field study efforts (rotary screw traps, snorkel survey, creel survey data) and will be completed by December of 2003.

Task 2—Describe the Life History and Habitat Requirements of Non-salmonid Fish Species in the Feather River Downstream of the Thermalito Diversion Dam to the Sacramento River Confluence

Information detailing the specific life history periodicities (e.g., adult spawning, juvenile rearing and migration), general habitat requirements (warmwater or coldwater, bottom or pelagic, lentic or lotic dwellers), specific habitat requirements (e.g., water depth, water velocity, substrate composition), and community interactions (predators, prey, competitors) of non-salmonid fish is necessary to effectively evaluate potential project effects on non-salmonid fish. Information regarding the habitat requirements, life history characteristics, and community interactions of the fish named in Groups A and B will be obtained from available general scientific literature, data and reports from studies conducted by federal and state agencies,

It is generally expected that existing scientific literature and reports will be able to provide the required information for Group A and B non-salmonids. In cases where local or regional studies have documented life history traits, those studies will be used. In cases where no local information regarding life history exists, life history traits from other geographic areas will be utilized. In cases where very little life history information exists in the literature (as anticipated for green sturgeon), information may be substituted from related species (such as shortnosed and caspian sturgeon).

Contingent on the information available, the following topics will be included in the review:

- Habitat requirements of non-salmonids by species and lifestage (habitat types, water temperatures, water depth, water velocity, substrate, etc.);
- Adult migration characteristics (timing, and water temperature and flow conditions);
- Spawning characteristics (habitat availability, timing, and factors affecting timing and success such as substrate conditions and water temperatures);
- Early development (factors affecting incubation and survival during incubation);
- Juvenile rearing (water temperature, flow, substrate characteristics, refuges, shade, cover, food availability); and
- Juvenile movements (timing, prevalent flow, water temperature and other abiotic conditions, predation, stranding).

This task will:

- Provide species-specific life history descriptions and habitat requirements for non-salmonid fish in the Feather River named in Groups A and B downstream of the Thermalito Diversion Dam to the Sacramento River confluence;
- Characterize the fish community (predators, prey, competitors) for Group A and B fish in the Feather River downstream of the Thermalito Diversion Dam to the Sacramento River confluence; and
- Classify fish species and/or their life stages in guilds according to their habitat requirements (warmwater or coldwater, bottom or pelagic, lentic or lotic dwellers).

Anticipated deliverables include tables or figures describing the life history of Group A and B fish species, and tables, figures, or narratives documenting habitat characteristics for Group A and B non-salmonids. The final report integrating the information detailed above will be completed by December 2002.

Task 3—Complete Identified Field Data Collection Efforts and Specific Analyses for Sturgeon and Splittail

Two non-salmonid species being considered under this study plan are either federally listed as threatened (splittail) or are a candidate for listing (green sturgeon). As mentioned earlier, the existing desktop information is expected to be insufficient to satisfy the objectives of Task 1 for green sturgeon in the Feather River. Little information exists regarding either green or white sturgeon in the Feather River (USFWS 1995) and therefore specific field studies designed to provide additional information on green sturgeon distribution and habitat characteristics have been proposed in Task 3A. Additionally, specific analyses for evaluation of potential project effects on splittail have been identified and are detailed in Task 3B. Existing distribution information is expected to be adequate for river lamprey, and no additional field studies have been identified as necessary for this species.

Task 3A—Identify Green Sturgeon Distribution and Habitat Use Patterns

Introduction. Relative to salmonids, little information on green sturgeon life history and habitat requirements exists. Due to the scarcity of available data and the anticipated challenges of field data collection regarding green sturgeon, information on both the green and white sturgeon will be collected in an effort to gain a better understanding of the green sturgeon's distribution and habitat preferences. Sturgeon are anadromous fish that spawn in rivers on the west coast, but spend most of their life in estuarine and marine environments, ranging geographically from southern Alaska to Mexico (Cramer & Associates 2002). Sturgeon are known to migrate into the Feather River, but detailed information regarding their reproduction is limited (USFWS 1995). In the mid-70s, green sturgeon were caught each year, with the majority of catches occurring from March to May and a few additional catches occurring in July and August (USFWS 1995). As recently as 1993, adult green sturgeon have been caught at the Thermalito Afterbay outlet (USFWS 1995).

Adult green sturgeon appear to migrate upstream into freshwater beginning in the latter part of February and may continue migrating as far as 200 miles upstream before spawning (in the Sacramento River) (Cramer & Associates 2001). Adult white sturgeon migrate into the Sacramento River beginning in October (USFWS 1995). In the Feather River, several potential physical upmigration passage barriers have been suggested, including Shanghai Bench, Sunset Pumps, and a steep riffle reach one to two miles upstream of the Thermalito Afterbay outlet (USFWS 1995). Although most white sturgeon spawning occurs in March and April, spawning may begin as early as February and may continue into June (USFWS 1995). Catch data indicate that most green and white sturgeon spawning in the Feather River occurs from March through May (USFWS 1995). In areas outside of the Central Valley, sturgeon spawn over rocks, compact clay substrates, or large gravels at depths of approximately 30 feet with water velocities ranging from 5-10 fps, while Central Valley sturgeon have been observed using gravel, rubble or soft-bottom stream reaches for spawning (USFWS 1995). On the Rogue River in Oregon, holding sites were typically deeper than 5 meters, with in-river residence time ranging upwards of 6 months (IEP 2001). Spawning locations for green sturgeon in the Feather River are unknown, but it has been suggested that spawning may be limited to areas just downstream of the Thermalito Afterbay outlet (USFWS 1995). Based on angler catch rates, spawning has been suggested to occur downstream of the Thermalito Afterbay outlet and Gridley Bridge (USFWS 1995).

Juveniles may spend 1 to 4 years in freshwater and estuarine environments before entering saltwater habitats (Cramer & Associates 2001). Most of the adult lifestage is spent in the ocean, and adults may undergo long migrations (Cramer & Associates 2001). Adult green sturgeon females are generally mature by age 20-25 years (6-7 feet in length), while males mature at approximately 15-17 years (5-6 feet in length) (Cramer & Associates 2001).

Adult upstream passage. Detailed passage criteria, such as those developed for salmonids, have not been developed for green or white sturgeon, and therefore several methods are proposed in combination to evaluate sturgeon passage over identified potential upmigration barriers. Because quantitative passage criteria are not available for green or white sturgeon, the passage evaluation methods proposed are necessarily either subjective or exploratory. The two methods proposed here include exploratory scuba diving surveys and assessment of the potential passage barriers by a sturgeon passage expert or experts. Three potential physical upstream migration barriers have been identified: Shanghai Bench, Sunset Pumps, and the steep riffles in the reach 1 to 2 miles upstream of the Thermalito Afterbay outlet (USFWS 1995).

Expert assessment of potential sturgeon passage impediments. Shanghai Bench, Sunset Pumps, and the steep riffles 1 to 2 miles upstream of the Thermalito Afterbay outlet have been tentatively identified as possible upstream passage impediments for adult sturgeon at low flows. The potential passage barriers to sturgeon will be observed and analyzed by at least one sturgeon passage expert accompanied by a team of agency representatives and other scientists involved in Oroville FERC relicensing. The sturgeon passage expert(s) will assess the likelihood of passage impediment at Shanghai Bench, Sunset Pumps, and the steep riffles in the reach 1 to 2 miles upstream of the Thermalito Afterbay outlet by visiting these areas at low flows (preferably in late spring/early summer of 2002). Additionally, the expert(s) will characterize the substrate at these potential passage barriers and will estimate whether the substrate is sufficient for allowing sturgeon to walk or "scooch" up the potential passage barrier at low flow. Over a range of flows, including low flow, photos of the potential passage barriers named above will be taken and evaluation of these photos by the sturgeon passage expert(s) will allow assessment of passage under other flow conditions. At Shanghai Bench, stage recorders will be installed to determine the stage at various flows as water passes over Shanghai Bench, which will provide additional data for use in the evaluation of potential upstream passage impediments.

The sturgeon passage expert(s) will prepare a report describing the assessment of the likelihood of adult sturgeon passage upstream of the potential barriers at low flows. If passage is deemed to be impeded at the lowest observed flows, the passage expert will determine the minimum flows that likely passage would be achieved. The interim report of the findings at low flow will be completed by November 2002. Photo series will be taken at each potential barrier in the first year following the implementation of the study plan. The final report, including the expert(s) assessment of passage under a variety of flows, will be completed 3 months following the completion of collection of the photo series.

Exploratory scuba surveys. Exploratory scuba surveys will be conducted to estimate whether adult sturgeon are holding downstream of potential upmigration barriers. Twice during the summer months (May/June and July, 2002 and 2003), scuba divers will dive just downstream of Shanghai Bench and Sunset Pumps, and at the pools downstream of the riffles in the reach 1 to 2 miles upstream of the Thermalito Afterbay outlet looking for adult sturgeon (both green and white sturgeon). As additional utilization of the scuba survey field data, any observations of adult early-upmigrant Chinook salmon holding in these areas will be documented and provided to Task 1E of SP-F10. If adult green or white sturgeon are seen holding or spawning below these migration barriers, this study plan will attempt to catch them by electrofishing and if caught, will radio tag

them for tracking and observation of habitat use and migration and holding behavior. The electrofishing and radiotagging efforts are dependent upon the availability of take permits, personnel, and equipment. Some sturgeon may be placed upstream of the potential barrier and monitored to determine whether they continue upmigrating or return to their downstream holding location. The intent of this experimental release is to determine whether or not adult sturgeon will continue to migrate upstream if placed above the potential migration barrier. Radio-tracking methods are detailed under the section titled "sturgeon distribution and habitat characteristics." An interim report detailing findings of the first year of exploratory surveys will be completed by November 2002. A final report, including finding of the 2003 surveys, will be completed by November 2003. Radiotagging studies initiated during scuba surveys will be summarized in the radiotagging study report in conjunction with the "sturgeon distribution and habitat characteristics" task below.

Sturgeon distribution and habitat characteristics: Little is known about the distribution of green and white sturgeon in the Feather River or about their habitat characteristics. In order to determine their habitat characteristics and distribution, radiotagging studies and egg/larval studies will be conducted.

Radio tagging and tracking (summer 2002). Twice during the summer months of 2002 (May/June and July), scuba divers will survey deep pools in 3 areas looking for adult green and white sturgeon. Scuba surveys will occur at the hatchery area, in bedrock pool at River Bend Park, and in the pool near Great Western riffle. These areas have been chosen because it has been suggested that holding habitat for adult sturgeon consists of deep bedrock pools. The diving survey area and frequency may be expanded or contracted depending upon the results of initial dives. If adult sturgeon are present in the dive areas, the following surveys may include additional dive sites. Alternatively, if in-river conditions in the dive areas make observation impractical, the new dive areas may be chosen or the survey may be discontinued. If adult green or white sturgeon are observed during the exploratory scuba surveys, pools will be electroshocked and adult green and white sturgeon will be radiotagged and sampled for genetic analysis. Electroshocking and radiotagging activities will be dependent upon permit, personnel, and equipment availability. If sturgeon are tagged, radio-tagging will be done in collaboration with the sturgeon tagging study currently conducted by UC Davis to investigate movement of sturgeon through the delta and into tributaries. Collaboration with this study may necessitate the use of specific types and brands of radio tagging equipment to be utilized and will be defined as coordination efforts with this other project are initiated after the approval of this study plan (SP-F3.2).

Adult sturgeon will be tagged and movements measured by both fixed receiver stations and by manual tracking in coordination with the weekly survey for radiotagged early-upmigrant adult Chinook (See Task 1E, SP-F10). Spawning locations, habitat usage, residence time, and outmigration patterns and timing will be investigated through the radio-telemetry survey. Tissues collected for genetic analysis will be analyzed by UC Davis researchers and compared to samples taken from other central valley sturgeon. Any juvenile green sturgeon observations will be recorded for use in the larval/juvenile sampling analysis (see below). As additional utilization of the scuba diving field crew, any observations of adult early-upmigrant Chinook salmon holding in these pools will be documented and provided to Task 1E of SP-F10. An interim report describing the findings of the radio-tagging efforts conducted in the summer of 2002 will be completed by December of 2002 in order to allow incorporation of the results into the study design for the radio tagging and tracking effort in spring of 2003. This report will also include a summary of any radiotagging initiated during scuba surveys.

Radio tagging and tracking (spring 2003): Upmigration of adult sturgeon likely begins in the Feather River in February and continues through the spring, with adults likely outmigrating in the fall. Beginning in February

2003, angling efforts will be initiated to capture adult upmigrant green and white sturgeon. Radio tagging and tissue sampling will proceed as described for the 2002 summer radio tagging effort in collaboration with UC Davis researchers. In addition, photos of each tagged sturgeon will be taken at the time of tagging. The tagging program will be used to determine sturgeon pre-spawning habitat use, spawning locations and timing, the upstream extent of green sturgeon migration in the Feather River, post-spawning habitat use, residence time in the Feather River, and outmigration patterns. In coordination with Task 1E in SP-F10, fixed station tracking and manual tracking will be used to determine tagged sturgeon locations. A final report describing the findings of the radio-tagging efforts conducted in the summer of 2003 will be completed by December of 2003.

Sturgeon egg and larval study: Sturgeon spawning areas have been characterized as having swift currents and dense substrates (Detlaff et al. 1993). Sturgeon outside the Central Valley commonly spawn over large gravel, rocks or compact clay substrates with depths greater than 10 m and velocities of 1.5-3.0 m/s (USFWS 1995c). Schaffter (1991) found evidence of Sacramento River sturgeon spawning over gravel and rubble bottoms. The lack of adhesiveness of the egg, in addition to the pale coloration, limited mobility and negative phototaxis of newly emerged green sturgeon larvae suggests that eggs may be trapped in the crevices of river bedrock or under gravel (Deng 2000). While larvae of many other sturgeon exhibit pelagic behavior and develop while drifting downstream in the water current, green sturgeon larvae most likely reside in the spawning grounds upon hatching, under pebbles and rocks.

It is unknown where sturgeon spawning occurs in the Feather River. Based on angler catches (USFWS 1995), potential spawning locations are likely to be downstream of the Thermalito Afterbay and Cox's Spillway (near Gridley Bridge). In the reach of the Feather River upstream of the Thermalito Afterbay outlet, water temperatures are generally cooler and may fall within the desired range for spawning, incubation and larval development. Sturgeon may spawn in this reach of the Feather River provided that flows allow for upstream passage to this cooler river reach. Egg and larval sampling for sturgeon may occur in the summer of 2002 and 2003, depending upon successful observations of adult or juvenile sturgeon in the scuba surveys. If the summer 2002 scuba survey suggests that adult sturgeon are present in the Feather River, the distribution of adults will be used to determine the sampling locations in the Feather River for a pilot egg/larval study occurring in summer of 2002. The pilot study will be experimental, and the expectations for the results of this experimental procedure are to establish the feasibility and requirements for a more intensive study and to identify the potential usefulness of future studies. Results of the pilot study and early summer 2003 dive surveys will determine if a subsequent egg and larval sampling effort will be conducted, or if it is conducted, the results will determine the sampling design for the summer of 2003 survey.

If conducted, field egg and larval sampling will occur in the area between the Fish Barrier Dam and Boyd's Pump, approximately two miles downstream of Shanghai Bend and may extend as far downstream as Verona. Depending upon results of the exploratory scuba survey, field surveys will be performed from March through May to acquire information on larval sturgeon rearing habitat in the Feather River, as well as larval sturgeon distribution. Sturgeon eggs have been found in the Sacramento River from mid-February through late May (Kohlhorst, 1976). Larval sampling will be conducted March through May using artificial substrates (condos) that may entrap eggs and/or shelter larvae. Condos will be constructed of PVC and 0.5-0.7 mm mesh. The condos will be set and retrieved during the day up to two times per week. Survey equipment design is preliminary and subject to change, based on results of the pilot study. Location, water temperature, flow,

substrate, depth and amount of time sampled will be recorded. Samples will be preserved in 10% formalin and sorted in the lab. Larval fish will be measured to the nearest 0.1 mm and enumerated.

If a pilot study is conducted in 2002, an interim report will be completed by September 2002. The interim report will present the results of the pilot study, evaluate survey equipment design, assess the potential usefulness of future studies, and aid in determining sampling intensity and location for the 2003 egg and larval study, if it is to be conducted. A final report will be completed by September 2003 and will include results from the 2003 egg and larval study if it is conducted.

Task 3B-Splittail Habitat Assessment

Creel survey data and rotary screw trap (RST) data suggest that splittail prefer the reach of the Feather River downstream of the confluence with Honcut Creek. Currently available information indicates splittail distribution is sporadic and their use of the Feather River varies from year to year (Sommer et al. 1997). They begin spawning in January, with peak spawning occurring from February – March, and may continue until April. Adult splittail forage in grassy areas when they arrive in the Feather River and spawn in inundated vegetation (Sommer et al., 1997). Juvenile rearing occurs in inundated vegetation for a period of several weeks to up to a year (Sommer et al., 1997). Splittail diet includes earthworms, amphipods, opossum shrimp and aquatic insect larvae (Moyle 1976). In the Feather River, the most valuable spawning and rearing habitat for splittail appears to be benches located at the mouth of the Feather River, which are inundated at high flows.

Splittail are known to spawn in relatively shallow, low-velocity areas of inundated vegetation. Therefore, altered river flows could affect the availability of potential splittail spawning habitat by reducing the amount of inundated vegetation occurring during the spawning season. In order to assess potential splittail spawning habitat, transects in the reach of the Feather River near its confluence with the Sacramento River (obtained from SP-G2) will be evaluated to determine the flows at which the benches near the mouth of the Feather River become inundated. From this data, stage-inundation relationships will be established. This information will be overlaid with the vegetation characterization (provided by SP-T4) to determine the amount of inundated vegetation (splittail spawning and rearing habitat) that would occur under a variety of flows. SP-T4 will survey vegetation to the confluence with the Sacramento River and will be informed of the specific information needs of SP-F3.2 with regards to the vegetated benches in this reach of the Feather River. Output from SP-E1.6 will be used to assess potential flow-related impacts to potential splittail spawning habitat availability under continued operations and under a variety of operational scenarios. This analysis can be used to determine the increase or decrease in inundated vegetation preferred by spawning splittail associated with specific changes in flow under various operational scenarios. This analysis may serve to suggest potential PM&E measures that could increase the amount of splittail habitat based on flow considerations. Additionally, water temperature information from SP-W6 will be compared to splittail water temperature preferences for both spawning and rearing lifestages. Water temperature preferences will be described in the literature review (Task 2), and will be compared to existing temperatures (SP-W6) to determine how project operations affect availability of water temperatures suitable to splittail. A final report detailing the results of these analyses will be completed 3 months following the end of transect data collection by SP-G2, and data collection in SP-T4 and SP-W6.

Task 4—Identify Fish Habitat in the Feather River from the Thermalito Diversion Dam to the Sacramento River Confluence, as it Pertains to Species-Specific Habitat Requirements

Task 4 identifies available habitat in the Feather River from the Thermalito Diversion Dam to the Sacramento River confluence. Description of available habitat will be based on a review and summarization of existing data and reports on physical, hydrological, and operational characteristics of the study area as the characteristics pertain to species-specific habitat requirements. Additionally, studies being completed as part of the FERC relicensing process will be reviewed and will provide data necessary to identify available habitat. The review will use available cartographic information (e.g., aerial photographs and topographic maps) and habitat characterization information obtained from SP-G2, SP-T4, SP-W6 and SP-W1.

GIS coverages of habitat components will be developed for evaluation to determine the location, extent and relative qualities of habitat by species by lifestage. Habitat locations will be determined by combining the habitat component coverage to identify areas with combinations of habitat characteristics that fit the profile of each fish's habitat preferences. Habitat components to be combined to identify fish habitat include:

- Mesohabitat maps (existing maps require registration and digitizing);
- Substrate characterization, transect data, channel morphology, assessment of woody debris, and cover cross-sectional monitoring data including water depth, velocity, and turbidity obtained from SP-G2;
- Inundation flow boundaries at various flow levels interpolated from SP-G2 channel transects;
- Vegetation survey results (grass, shrub, bush, tree classes) obtained from SP-T4;
- Water temperature data including water temperature measurements to the confluence of the Sacramento and Feather rivers in both riffles and deep pools obtained from SP-W6;
- Water quality data including turbidity and dissolved oxygen measurements obtained from SP-W1;
- Exceedences of water quality recommendations for freshwater aquatic life obtained from SP-W1;
- Macroinvertebrate community characteristics obtained from SP-F1; and
- Flow data obtained from USGS gaging stations.

In Task 4, habitat data from the study plans named above will be integrated to produce GIS coverages of existing habitat conditions. Additionally, Task 4 will utilize the information provided by Task 2 regarding habitat requirements for fish by lifestage. Data from Task 2 will be separated by species, or by guild if several related species have similar requirements. GIS coverages will be constructed that map the areas, which provide suitable habitat for each species or guild by superimposing the habitat requirements of each species or guild from Task 2 over the existing conditions (Task 4). Evaluation of the potential project effects on non-salmonid fish will occur under Task 5 by comparing the fish distribution information obtained from Task 1 and the habitat requirements obtained from Task 2, to the existing habitat in the Feather River from Task 4. The GIS coverages of each habitat component listed above and the GIS coverages describing habitat distribution by species or guild for each relevant lifestage will be presented in a final report, which will be completed three months following the completion of the first year of data collection in the supporting FERC

plans named above. Initial GIS coverages will be completed by December 2002 and presented in an interim report.

Task 5—Assess Potential Project Effects on Non-salmonid Fish Species

In Task 5, the information gathered in Tasks 1 through 4 will be used to evaluate the potential project effects on fish and their habitat. This task will provide an assessment of the potential project effects on the availability and quality of habitat for the various fish in the study area. The analysis of project effects on fish habitat will identify the factors likely to affect species-specific habitat requirements (water temperature, flow levels, and availability and/or quality of spawning, feeding and rearing habitat), the potentially affected fish species or fish guild, and the potential project-related effects.

Potential project effects on fish in the Feather River below the Thermalito Diversion Dam will be assessed using a habitat evaluation-based approach. Habitat characterization information will be provided by Task 3, including GIS coverages of habitat components (substrate characterization data, spawning gravel quality data, vegetation, inundated littoral vegetation data, instream cover and woody debris data, macroinvertebrate characterization, water temperature data, flow data and specific hydraulic information provided by SP-G2). As specified in SP-G2, monitoring and transect data collection will be conducted at a variety of flows. Habitat characteristics, including hydraulic information, can be compared to habitat requirements (determined in Task 2) to evaluate whether conditions meet habitat requirements and how project operations potentially influence habitat availability.

Task 5 will integrate species distribution information (Task 1) and habitat requirements (Tasks 2 and 3), and compare the existing habitat (Task 4) to the requirements at relevant locations and times for each species named in groups A and B. Task 5 is subdivided into two tasks for clarity: Task 5A assesses the potential effects of ongoing operations on non-salmonid fish, while Task 5B assesses the potential effects of alternative operational scenarios. The assessments in Task 5 will include Group A and B fish.

Task 5A-Assess Potential Project Effects of Ongoing Operations on Non-salmonid Fish Species

Feather River non-salmonids will be evaluated species-by-species and lifestage-by-lifestage. Species distribution by life stage (Task 1) will be compared to the location and extent of habitat identified as suitable for each species lifestage (Task 4) for each species and evaluated for differences potentially attributable to project effects or existing data quality limitations. In addition to evaluating potential project effects and data quality, empirically observed habitat conditions can be compared to habitat requirements described in the literature. For example, if it is found in Task 3 that adult sturgeon spend approximately 6 months in the Feather River, and inhabit only a certain reach of the river, then habitat requirements of adults will be compared with existing habitat conditions over those 6 months and in the appropriate geographic area of the river. The habitat requirements (as listed in Task 2) for lifestages of the non-salmonid species residing in the Feather River (Task 1) will be compared to the conditions that exist at the time of year and in the location of the river in which the fish are found (Task 4) to assess potential project effects of ongoing operations. For migratory fish (American shad and striped bass, for example), upstream passage will be evaluated by comparing upstream migration requirements (Task 2) to the existing conditions at potential passage barriers (see Task 3). Additionally, previous analysis of shad swimming ability (compiled in Task 2), angler catch rates (from analysis of creel survey data), and attraction flows from existing information (compiled in Task 2) will be utilized in this evaluation by comparing requirements to existing conditions (Task 3). Additional data

on distribution and habitat use by green sturgeon is anticipated and will be collected in Task 3A, while specific analyses for potential project effects on splittail are listed under Task 3B. If water quality exceedances are reported by SP-W1, this task will compare the magnitude and duration of the exceedance to habitat requirements (Task 2) to determine the impact of the water quality exceedances. A final report will be completed 4 months following completion of Task 4.

(Delete Task 5B and insert in future study plan once PM&E measures are developed)

Task 5B: Assess Potential Project Effects of Alternative Operational Scenarios on Non-salmonid Fish Species

Engineering and operations plans will model selected operational scenarios, and model output will be used to evaluate the potential project effects on non-salmonid fish under alternative operational scenarios. The influences of daily changes in flow and water temperature on the amount of available habitat will be evaluated under selected scenarios modeled by SP-E1.6, SP-E1.5 and SP-E6. Various scenarios will be evaluated against existing operations by estimating the net change in the amount and location of suitable habitat resulting from the alternative operational scenario relative to the amount and location of suitable habitat occurring under ongoing operations (Task 4). Model output from SP-E1.6, SP-E1.5 and SP-E6 will be used to describe flow and water temperature conditions for various operational scenarios. The evaluation of habitat occurring under various operational scenarios will occur as described in Task 5A, using model output as opposed to existing conditions to determine flow and water temperature conditions. Flow and water temperature will be the two primary variables investigated, as they are the two project-controlled variables that will be modeled for response to change in operations. As the various model scenarios indicate changes in habitat variables creating or reducing the amount of habitat, the amount of resulting increase or decrease of suitable habitat will be quantified and documented for use in potential PM&E evaluations. A final report will be completed 4 months following completion of Task 4 and model simulations under varying operational scenarios.

6.0 Results and Product/Deliverables

Results

Results will be organized following the task headings. Each task will include a narrative of the relevant findings as well as tables, figures and maps summarizing the key points. The results of the four sections will be integrated to evaluate potential project effects on fish habitat and resultant impacts on fish populations. The anticipated maps, graphical representation of reviewed data (e.g., charts, and graphs) and summary figures and tables include:

- Maps, figures, narratives, or tables showing geographic and temporal distributions of fish species (Task 1);
- Figures, tables or narratives summarizing lifecycle periodicity for identified study area fish species and figures, tables, or narratives summarizing main habitat suitability characteristics for spawning, juvenile rearing and migrations of identified study area fish species (Task 2);
- Maps, figures and narratives of sturgeon distribution, habitat utilization, migration and emigration timing and passage (Task 3A);

- Splittail spawning and incubation distribution maps (Task 3B);
- GIS coverages of habitat components and habitat distribution by species, species guild and/or lifestage (Task 4);
- Tables and narrative of congruence and discongruence of fish distribution vs. fish habitat by species and/or species guild (Task 5A); and
- Tables of potential habitat increases and decreases by operational scenario (Task 5B).

Products/Deliverables

The study plan summary report will include:

- Executive Summary
- Table of Contents
- List of Tables
- List of Figures
- Introduction
- Methodology
- Narratives of relevant findings by task
- Discussion addressing most relevant questions (see above) and indicating any complications/data concerns
- Conclusions related to study plan goals and objectives
- References
- Appendices

7.0 Coordination and Implementation Strategy

Coordination with Other Resource Areas/Studies

It is anticipated that this study will require coordination with those individuals responsible for collecting temperature, flow and project operation data, performing biological surveys, and conducting hydraulic and channel morphology studies. In particular, coordination with the DWR work group currently responsible for the study plan SP-W6-Project Effects on Temperature Regime will be required prior to the start of water temperature monitoring. Also, coordination with the DWR group evaluating the information for the IFIM/PHABSIM model (study plan SP-F16-Evaluation of Project Effects on Instream Flows and Fish Habitat (PHABSIM) is required. Contact with DFG and USGS also are expected.

Given the nature of the tasks of this study, contacts with work groups directing and conducting other studies relevant to the Oroville Facilities FERC Relicensing Project also are expected. A preliminary list of study plans that will be related to the development of the present study includes:

- SP-F1-Evaluating the Impacts of Project Operation on Non-fish Aquatic Resources

SP-F1 will provide information including an inventory of macroinvertebrates occurring in the study area and the types and abundance of macroinvertebrates located at various sampling locations.

- SP-F10—Evaluation of Project Effects on Anadromous Fish and their Habitat

SP-F3.2 will provide information to Task 1E if information on spring-run life history exhibiting fish are observed in the scuba surveys conducted in Task 3A. Adult sturgeon will be tagged and movements measured by both fixed receiver stations and by manual tracking in coordination with the weekly survey for radiotagged early-upmigrant adult Chinook (See Task 1E, SP-F10).

- SP-F21—Project Effects on Predators of Feather River Anadromous Salmonids

SP-F3.2 will provide information pertaining to life history characteristics, distribution and habitat requirements of fish that prey on juvenile salmonids to SP-F21.

- SP-W1—Project Effects on Water Quality Designated Beneficial Uses for Surface Waters

SP-W1 will compare water quality conditions to criteria established for freshwater aquatic life under Task 2 of SP-W1 and will report exceedances for impact analysis on non-salmonid fish to Task 5A of SP-F3.2. SP-W1 will also provide water quality data including dissolved oxygen measurements and turbidity for use in Task 4 of SP-F3.2.

- SP-W6—Project Effects on Temperature Regime

SP-W6 will provide temperature profiles to SP-F3.2 as specified in SP-W6. Temperature information may be integrated into habitat characterization maps of SP-3.2 Water temperature information from SP-W6 will be compared to splittail water temperature preferences for both spawning and rearing lifestages in Task 3B. Water temperature preferences will be described in the literature review (Task 2), and will be compared to existing temperatures (SP-W6) to determine how project operations affect availability of suitable water temperatures in Task 5A.

- SP-T4—Biodiversity

SP-T4 will catalogue riparian vegetation for WHR mapping and will collapse the WHR classes into grasses, shrubs, bushes, and trees for use in SP-F3.2. SP-T4 will also provide SP-F3.2 with information regarding the amount of inundated littoral vegetation including assessment of the amount and location of inundated aquatic vegetation. Information collected from these surveys will be entered into GIS for habitat coverages under Task 4 of SP-F3.2.Vegetation characterization (provided by SP-T4) will be used by SP-F3.2 Task 3B to determine the amount of inundated vegetation (splittail spawning and rearing habitat) that would occur under a variety of flows.

- SP-G2—Effects of Project Operations on Geomorphic Processes Downstream of Oroville Dam

In order to maximize cost-effectiveness, SP-G2 will provide SP-F3.2 with required geomorphic information for the Feather River. Fieldwork completed in plan SP-G2 will support habitat characterization efforts in SP-F3.2. SP-F3.2 will get transects in the reach of the Feather River near its confluence with the Sacramento River from SP-G2 to determine the flows at which the benches near the mouth of the Feather River become inundated for the splittail spawning habitat evaluation to be conducted in task 3B. Data obtained from SP-G2

for the purpose of habitat characterization (Task 4) will include measurements of geomorphic parameters, substrate characterization, and assessment of woody debris and cover. Specific information and methodologies for obtaining these data to fulfill fisheries needs are given below.

Geomorphic parameters including channel width, depth, cross-section, hydraulic radius, and roughness will be collected as specified in SP-G2. Substrate will be characterized in each habitat type occurring at each cross-section using both the Wolman pebble count method and gravel sieving as specified in Tasks 2 and 3 of SP-G2. Substrate characterization will include particle size down to 0.1 mm in diameter. Following substrate characterization, gradation curves will be produced by SP-G2. These curves will illustrate the grain-size cumulative and percent distribution and will be useful for assessing the suitability of spawning habitat.

Spawning gravel quality will be visually assessed to describe gravel shape and embeddedness using the method used by SCE during relicensing of the Big Creek Hydroelectric Facilities. This assessment will occur during Wolman sampling and gravel sieving (Task 2 and 3, SP-G2). The quality of spawning gravel will be determined based on both angularity and embeddedness. Gravel of high spawning suitability is highly rounded, with little sand and fines and low embeddedness. Spawning gravel is considered of low quality if it is angular or if it is highly embedded with a high proportion of sand, regardless of angularity. The scoring criteria for spawning gravel quality are listed below:

Spawning Quality Rating	**Description of Substrate**
Excellent	Round-shaped spawning gravels loose in substrate.
Good	Round-shaped spawning gravels slightly embedded in substrate *or* moderately jagged-shaped spawning gravels loose in substrate.
Fair	Round-shaped spawning gravels embedded in substrate *or* moderately jagged-shaped spawning gravels slightly embedded in substrate.
Poor	Round-shaped *or* jagged-shaped spawning gravels deeply embedded in substrate.

Cover will be assessed by SP-G2 using a classification system currently in use by DWR. This cover classification system is described below:

Cover code	**Cover description**
A	No apparent cover
B	Small to medium instream objects/woody debris (<31 cm or 1 ft. in diameter)
C	Large instream objects/woody debris (>31 cm or 1 ft. in diameter)
D	Overhead objects
E	Submerged aquatic vegetation
F	Undercut bank

The dominant cover type will be noted. Additionally, if the dominant cover type is large instream woody debris (Code C), the number of total pieces of wood in or intersecting the active stream channel will be counted and recorded. Wood will be counted if greater than one-third of the length of each piece of wood is

situated within the stream channel. Each piece of wood satisfying these criteria found in debris jams will be counted and recorded.

SP-F3.2 will obtain mesohabitat characterization data from Task 2 of SP-G2 for the reach of the Feather River extending from the confluence of Honcut Creek to the Sacramento River. Habitat characterization will be conducted using the following habitat characterization scheme, which includes designating habitat as riffle, run, pool, or glide based on gradient, substrate size, water velocity, depth, and turbulence. The table below lists the criteria (Beak 1989) for defining each habitat unit:

Habitat Unit	Defining Characteristics
Riffle	Relatively high gradient with substrate of large gravel and/or cobble; relatively high water velocities; relatively low depth; surface turbulence; channel controlled (i.e., no backwater influence).
Run	Moderate gradient with a substrate of small cobble and/or gravel; relatively high water velocities; average depth; low to moderate turbulence; channel controlled; generally associated with the downstream extent of riffles.
Pool	Relatively low gradient with substrate of fine materials; relatively low water velocities; relatively high depth; tranquil; section controlled.
Glide	Relatively low gradient with substrate of small gravel and/or sand/silt; relatively low water velocity; relatively low depth; no turbulence; variable control; generally associated with the tails of pools and heads of riffles.

Engineering and Operations Workgroup Studies and Models

Output from SP-E1.6 -Feather River Flow-State Model Development will be used to assess potential flow-related impacts to potential splittail spawning habitat availability under continued operations and under a variety of operational scenarios (Task 3B). Output from SP-E1.6 will also be used to describe the flow conditions under various operational scenarios for assessment of potential project effects on non-salmonids under alternative flow regimes (Task 5B). Additionally, model output from SP-E1.5-Feather River Temperature Model Development and SP-E6-Downstream Extent of Reasonable Control of Feather River Temperature by Oroville-Thermalito will be used to describe the water temperature conditions under various operational scenarios for assessment of potential project effects on non-salmonids under alternative water temperature conditions (Task 5B).

Issues, Concerns, Comments Tracking, and/or Regulatory Compliance Requirements

This study fully or partially addresses the following Stakeholder issues:

Stakeholder issues fully addressed by SP-F3.2 Evaluation of Project Effects on Non-salmonid Fish in the Feather River Downstream of the Thermalito Diversion Dam

Issue	Description
F1	Effects of existing and future project operations (including power generation, water storage and releases, ramping rates, pump-back, water levels, and water level fluctuations) during all water year types on the behavior (e.g., migration timing, microhabitat selection, vulnerability to predators), reproduction, survival and habitat of warm- and cold-water fish and other aquatic resources (e.g., macroinvertebrates) in project waters, which include tributaries within the project boundaries (lake Oroville, Diversion Pool, Fish Barrier Pool, Forebay, Afterbay, Oroville Wildlife Area), and in project affected waters. Also addressed in SP-F3.1, SP-F10, SP-F21 and SP-F1.
F3	Project effects on resident fish species (e.g., trout and other salmonids and warm-water fish) habitat quantity and quality (including instream flow, sediment, woody debris, water temperature, etc) and habitat for other aquatic species. Also addressed in SP-F3.1 and SP-F10.
F5	Effects of existing and proposed fisheries management plan(s) and activities on a balanced cold- and warm-water fishery (including stocking levels, hatchery management and production relative to in-river populations, habitat enhancement projects, predator and undesirable species control and preservation of future introductions (e.g., Northern pike, striped bass, etc), disease, tree stakes and tire removal, and harvest). Also addressed in SP-F9, SP-F2, SP-F3.1, and SP-F21.
F6	Effects of existing and future project operations on sediment deposition, erosion, and recruitment through the system (including downstream sediment supply) and associated changes in water quality on the quantity and quality of aquatic habitats within project affected waters. Also addressed in SP-G1, SP-G2, SP-W1, and SP-F3.1.
F7	Project effects on interactions, including predation and competition, among lake and tributary fish populations (e.g., land-locked Chinook salmon, trout, bass, and other land-locked species) that affect species abundance, growth, reproduction and survival. Also addressed in SP-F3.1 and SP-F21.
F16	Effects of existing and future project facilities and operations on the abundance of predators, their seasonal and geographic distribution, the impact of predation mortality on population dynamics of salmonids and other species, and alternatives for predator control and management (including prevention of introductions). Also addressed in SP-F21 and SP-F3.2.
FE15	Develop and maintain a balanced fishery. Also addressed in SP-F3.1.
FE57	Provide habitat leading to viable populations of endangered species. Maintain habitat to support viable populations of all native and desired nonnative vertebrate species. Also addressed in SP-F3.1 and SP-F10.

Issue	Description
FE58	Improve and protect habitat for designated emphasis and harvest species. Identify and evaluate potential conflicts among project effects and management actions for protected and sensitive species. Also addressed in SP-F10 and SP-F3.1.
FE75	Project structures or operations that either have in the past, or continue to introduce predators, create suitable habitat for predators, harbor predators, or are conducive to the predation of salmonids. Also addressed in SP-21 and SP-F3.1.
FE95	The lower Feather River provides habitat to support a variety of anadromous fish species including Chinook salmon, steelhead, striped bass, American shad and sturgeon. Potential changes in license conditions could adversely impact habitat supporting these species. Habitat investigations should evaluate the existing quality and quantity of habitat and determine alternative improvements for the various life history needs of anadromous species including flow, water temperature, instream and riparian cover, substrate and spatial area. Also addressed in SP-F10.
FE96	The lower Feather River provides habitat to support a variety of resident native and resident introduced species including coldwater species such as rainbow, brook, and brown trout, and warm water species such as bass, catfish, bluegill, green sunfish, carp and others. Potential changes in license conditions could adversely impact habitat supporting these species or upset habitat conditions such that less desirable species are favored. Habitat investigations should evaluate the existing quality and quantity of habitat and determine alternative improvements for the various life history needs of these resident native and non-native species including flow, water temperature, instream and riparian cover, substrate and spatial area. Also addressed in SP-F10.
FE97	The habitat for fishes in the lower Feather River is affected by the flow releases from the project. Seasonal timing, volume, and rate of release all have an affect on fish habitat conditions. Potential changes in license conditions for flow releases could adversely affect habitat conditions for one or more fish species. Fishery investigations should examine the adequacy of flows for maintaining all life history needs for anadromous and resident species. There should be evaluation of potential for flow improvements in the low-flow section. Fishery investigations should be sufficient to determine how best to meet the combined needs of the various anadromous and resident fish species. Also addressed in SP-F10 and SP-F16.

Source: National Environmental Policy Act (NEPA) Scoping Document 1 and California Environmental Quality Act (CEQA) Notice of Preparation.

8.0 Study Schedule

	Timing/Deadlines		
Task	**Field data collection/analysis occurring in SP-F3.2**	**Interim Report**	**Final Report**
1	Compilation of existing distribution and abundance data	December 2002	December 2003
	Examination and analysis of raw data not included in reports		
2	Description of life history information for Group A and B species	N/A	December 2002
	Description of habitat characteristics for Group A and B species		
3A	Expert assessment of potential sturgeon upmigration barriers (during low flows in late spring/early summer 2002)	November 2002	3 months following completion of photo series
	Photo series of upmigration barriers under varying flows (1 year data collection following implementation of study plan)	N/A	
	Exploratory scuba survey (spring/summer 2002 and 2003)	November 2002	November 2003
	Radio tagging and tracking study (summer 2002 and spring 2003)	December 2002	December 2003
	Sturgeon egg and larval study	September 2002	September 2003
3B	Establish stage-inundation relationships; calculation of amount of inundated vegetation at various flows; comparison of existing temperatures to water temperature preferences for splittail	N/A	3 months following the completion of transect data collection in SP-G2, and data collection in SP-T4 and SP-W6
4	Create GIS coverages of each habitat component supplied by supporting FERC plans and coverages of habitat distribution by species	December 2002	3 months following the completion of the first year of data collection from named supporting FERC plans
5A	Assess potential project effects of ongoing operations	N/A	4 months following the completion of Task 3
5B	Assess potential project effects of alternative operational scenarios	N/A	4 months following the completion of Task 3 and model simulations

9.0 References

A complete list of references used in the completion of the study will be part of the summary report. The references cited in the present plan are listed below.

Cramer & Associates. 2002. Green Sturgeon Status Review Information. Prepared for State Water Contractors by Beamesderfer, R.C.P., and M.A.H. Webb. March 13, 2001. Gresham, OR.

Deng, X. 2000. Artificial reproduction and early life stages of the green sturgeon (Acipenser medirostris). MS Thesis, University of California, Davis, California.

Dettlaff, T.A., A.S. Ginsburg and O.I. Schmalgauzen. 1993. Sturgeon fishes - developmental biology and aquaculture. New York, NY: Springer-Verlag

DWR. 2000. 1999 Lake Oroville Annual Report of Fish Stocking and Fish Habitat Improvements, February 2000.

DWR. 2001. Initial Information Package, Relicensing of the Oroville Facilities, January 2001.

DWR and USBR. 2000. Biological Assessment: Effects of the Central Valley Project and State Water Project on Steelhead and Spring-run Chinook Salmon, November 2000.

Interagency Ecological Program (IEP) for the San Francisco Estuary Newsletter. 2001. Vol. 14, Number 4. Fall 2001. Available at: http://iep.water.ca.gov/report/newsletter/2001fall/IEPNewsletterFall2001.pdf

Kohlhorst, D. W. 1976. Sturgeon spawning in the Sacramento River in 1973, as determined by distribution of larvae. California Fish and Game 62(1): 32-40.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press, Berkeley.

Painter, R. E., L. H. Wixom, and S. N. Taylor. 1977. An evaluation of fish populations and fisheries in the post-Oroville project Feather River. Sacramento, California, Department of Fish and Game, Anadromous Fisheries Branch.

PCWA and USBR. 2001. PCWA American River Pump Station Project. Draft of Environmental Impact Statement/ Environmental Impact Report, August 2001.

Schaffter, R.G. 1997. White sturgeon spawning migrations and location of spawning habitat in the Sacramento River, California. California Fish and Game 83(1): 1-20.

Sommer, T., Baxter, R., and B. Herbold. 1997. Resilience of Splittail in the Sacramento-San Joaquin Estuary. *Trans. Am. Fish. Soc*. 126:961-976.

USFWS. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 3. May 5, 1995. Prepared for USFWS under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, CA.

Yoshiyama, R. M., E. R. Gerstrung, F. W. Fisher, and P. B. Moyle. 1996. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California in Sierra Nevada Ecosystem Project. Final Report to Congress, vol. III: Assessments, Commissioned Reports and Background Information. (University of California, Davis, Centers for Water and Wildland Resources, 1996.)